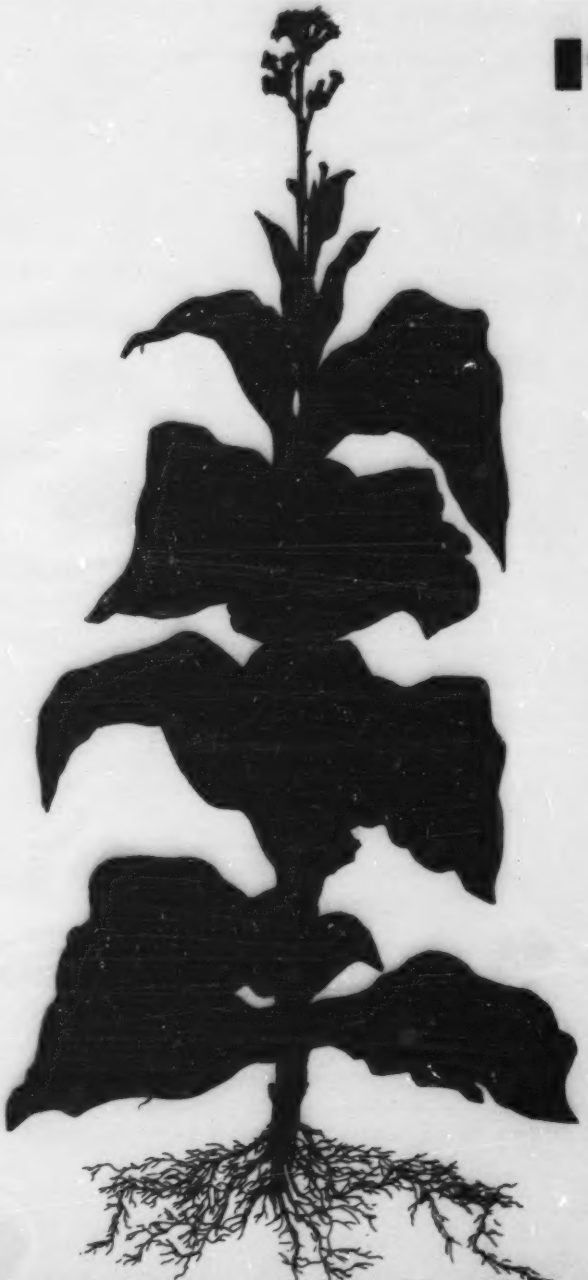
TOBACCO DISEASES

PUBLICATION 1641
1978

Agriculture
Canada



Copies of this publication may be obtained from
INFORMATION SERVICES
CANADA DEPARTMENT OF AGRICULTURE
OTTAWA
K1A 0C7

©Minister of Supply and Services Canada 1978

This publication replaces Publication 998, *Tobacco Diseases in Canada*.

15M-38931-3:78

Cat. No.: A53-1641/1978
ISBN: 0-662-01506-1

Kromar Printing Ltd.
Contract No.: 01A05-7-38931

102-06583/

CONTENTS

INTRODUCTION 7

THE STRUCTURE OF THE TOBACCO PLANT 8

- ROOT 9
- STEM 9
- LEAVES 10
- FLOWERS 10

WHAT IS A DISEASE? 11

SYMPTOMS OF DISEASE 11

CAUSES OF DISEASE 11

- FUNGI 11
- BACTERIA 11
- VIRUSES 11
- NEMATODES 12
- PARASITIC FLOWERING PLANTS 12
- ENVIRONMENT 12

MEASURES FOR DISEASE PREVENTION 12

- RESISTANT VARIETIES 12
- SUITABLE SOIL 12
- PROPER CULTURAL PRACTICES 12
- SANITATION 13
- CHEMICAL PROTECTION 13

STERILIZATION OF TOBACCO SEEDBEDS 13

- STERILIZING WITH STEAM 13
- STERILIZING WITH CHEMICALS 14

DISEASES IN THE SEEDBED 15

- DISEASES CAUSED BY FUNGI 15
  - Molds and mushrooms 15
  - Damping-off 15
  - Black root rot 17
  - Blue mold 17
- DISEASES CAUSED BY NEMATODES 18
  - Root-knot 18
- NONPARASITIC DISEASES 18
  - Tipping-over 18
  - Cold injury 19
  - Yellow patch 19
  - Injury by 2,4-D 20
  - Injury by fumes from wood preservatives and paints 20

DISEASES CAUSED BY FLOWERING PLANTS 21
Field dodder 21
DISEASES IN THE FIELD 23
DISEASES CAUSED BY FUNGI 23
Blue mold 23
Black root rot 23
Sore-shin 24
Fusarium wilt 24
Verticillium wilt 26
Brown leaf spot 26
Frog eye 27
Stalk rot or rattle box 29
Dead-blossom leaf spot 29
DISEASES CAUSED BY BACTERIA 29
Angular leaf spot 29
Wildfire 31
Hollow stalk 32
Frenching 33
DISEASES CAUSED BY NEMATODES 34
Brown root rot 34
Root-knot 35
DISEASES CAUSED BY VIRUSES 36
Tobacco mosaic 36
Cucumber mosaic 37
Ringspot 37
Streak 37
Etch 39
Potato virus Y 40
DISEASES CAUSED BY FLOWERING PLANTS 40
Broom rape 40
NONPARASITIC DISEASES 41
Weather fleck caused by air pollution 42
Frost damage 44
Lightning injury 44
Hail injury 44
Sun scald or sun burn 46
Drought spot 46
Drowning 46
NUTRITIONAL DISEASES 48
Nitrogen deficiency 48
Excess of nitrogen 48

Phosphorus deficiency 49
Potassium deficiency 49
Magnesium deficiency 50
Calcium deficiency 50
Boron deficiency 50
Sulfur deficiency 51
Manganese deficiency 51
Zinc deficiency 51
Copper deficiency 51
Iron deficiency 51
Gray tobacco 51
KEY TO MINERAL DEFICIENCY DISEASES OF TOBACCO 52-53
DISEASES IN THE CURING BARN OR KILN 54
Pole rot, barn rot, or house burn 54
ACKNOWLEDGMENTS 56

TOBACCO DISEASES

S. K. GAYED
Research Station, Delhi, Ontario

INTRODUCTION

Long before the first French settlers came to Canada in 1535, the native Indians had been growing and smoking tobacco, probably for more than 500 years. By 1800, tobacco was produced commercially along the St. Lawrence and Ottawa rivers in Quebec and in Essex and Kent counties in Ontario. Ever since 1835, when the government encouraged tobacco production, the industry has expanded steadily. The greatest expansion started in the 1920s, when tobacco was grown in Ontario in the new belt of Norfolk, Oxford, Elgin, and Brant counties. Tobacco has been grown in the Maritime Provinces of Prince Edward Island, Nova Scotia, and New Brunswick since 1961.

The total area of all types of tobacco grown in Canada in 1975 was 42 027 ha *(103 771 ac)* grown in the following provinces.

Type of tobacco	Ontario	Quebec	Maritime Provinces
Flue-cured	35 519 ha *(87 702 ac)*	3113 ha *(7688 ac)*	2025 ha *(5000 ac)*
Burley	464 ha *(1145 ac)*	—	—
Dark	227 ha *(561 ac)*	—	—
Cigar filler	—	608 ha *(1500 ac)*	—
Pipe	—	71 ha *(175 ac)*	—
Total	36 210 ha *(89 408 ac)*	3792 ha *(9363 ac)*	2025 ha *(5000 ac)*

Flue-cured tobacco grows best on well drained sandy soil low in organic matter. Burley tobacco may be grown on soil containing twice as much organic matter and 5–10% more silt and clay. Cigar and pipe tobacco require soils higher in nitrogen and potash content. Therefore, gravelly loams and river soils with natural fertility and organic matter are the best for cigar and pipe tobacco.

A frost-free period of 100–125 days is essential for growing tobacco in Canada. Tobacco is a heat-loving plant that needs long, warm, and bright days during the growing season for proper development and maturation.

THE STRUCTURE OF THE TOBACCO PLANT

A tobacco plant is composed of a root and a stem that carries leaves and flowers (Fig. 1).

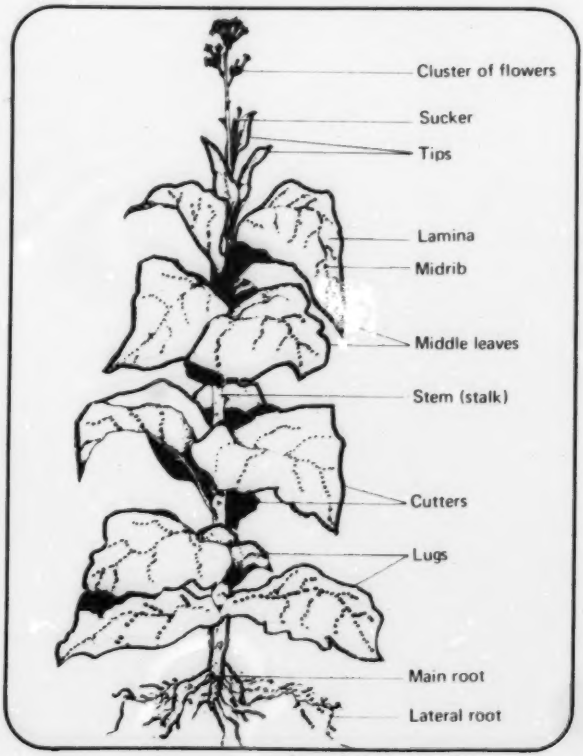


Fig. 1. A tobacco plant, "flue-cured" or "Virginia type."

ROOT

The root consists of a main and many secondary or lateral roots. The root system fixes the plant to the soil and absorbs water and nutrients. The nicotine forms first in the root before it is translocated to the leaf. The root has a conducting tissue surrounded by a cortex (Fig. 2). Water and food are translocated to and from the stem through the conducting tissue. The wide cortex of the root stores necessary food.

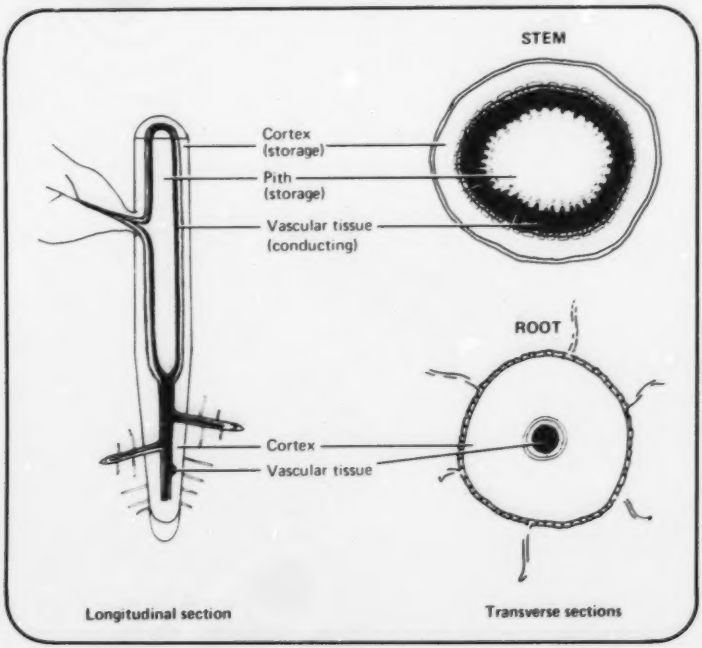


Fig. 2. The diagrammatic structure of a root and stem of tobacco.

STEM

The stem carries the leaves at the nodes and the flowers at the tip. The conducting tissue of the stem is peripheral, surrounding a wide pith. Outside the conducting tissue there is a cortex. Cells of both pith and cortex are for storage of food. The conducting tissue of the stem is continuous with that of the root and the leaf.

LEAVES

The leaves are composed of a midrib and a lamina. The midrib and the veins of the leaf are its vascular supply. There are very tiny pores, particularly on the lower surface of the leaf, called stomata (Fig. 3). These are open during daytime to allow air inside the leaf. Air carries a certain portion of carbon dioxide gas. In the presence of the green pigment chlorophyll in the leaf cells and the energy from the sun, carbon dioxide reacts with water in the cell to form sugar. From this sugar other food materials are prepared. Food formed in the leaf is translocated to the stem and root through the conducting tissue.

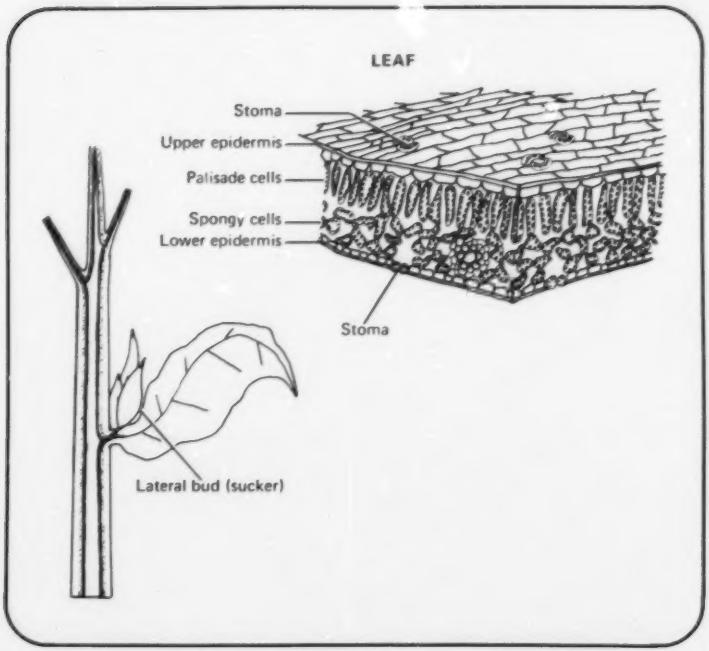


Fig. 3. The diagrammatic structure of a tobacco leaf.

FLOWERS

The flowers form as a cluster at the tip of the plant. After pollination, the ovary of the flower becomes a pod in which the small brown tobacco seeds form.

WHAT IS A DISEASE?

A disease is a disturbance in the function of an organ. Diseases can affect the root, which reduces the water and mineral supply; the stem, which reduces the food supply; or the leaf, which interferes with the vital process of building up food materials.

SYMPTOMS OF DISEASE

- Change in the size of the whole plant or part of it.
- Change in the color of the root, stem, or leaves. Roots may become black or brown; spots of different colors may also form on the stem or leaves.
- Wilting of the plant, in spite of adequate water supply.
- Failure to produce healthy flowers and seeds.

CAUSES OF DISEASE

Diseases are caused by certain fungi, bacteria, nematodes, parasitic flowering plants, or viruses, and can be induced by unfavorable environmental conditions.

FUNGI

Fungi are lower plants, which are devoid of the green pigment called chlorophyll. Because they are unable to prepare their own food, they subsist either on organic matter in the soil, foodstuffs, dead wood, and so on, or on living plant cells. The fungus not only deprives the plant cell of its food, but it may secrete poisonous substances that damage the cells. Fungi produce a large number of reproductive units called spores, which spread by wind, water, or animals. Under favorable moisture and temperature conditions, spores germinate and the tubes formed penetrate the plant and branch in the internal tissues and cause disease.

BACTERIA

Similar to fungi, bacteria lack the green pigment chlorophyll. Bacteria are single-celled microscopic organisms. Bacteria released from diseased host-plant tissue furnish a source of infection. They spread to healthy plants by means of splashing rain, animals, or man.

VIRUSES

Viruses are organisms that are too small to be seen by a light microscope, but they can be studied and their particles

photographed with the aid of an electron microscope. When viruses infect plants, they multiply rapidly in the living cells.

NEMATODES

Plant-parasitic nematodes are tiny, usually microscopic, roundworms that feed on roots and plant residues in the soil. A high population of nematodes in the roots causes severe damage and stunting of the plant and a decrease in yield.

PARASITIC FLOWERING PLANTS

Parasitic flowering plants lack the green pigment chlorophyll so they parasitize green plants. Some of the parasitic plants attack roots, whereas others are stem parasites. When a contact between the parasite and the host is established, the food material prepared in the host tissues moves to the parasitic plant.

ENVIRONMENT

Environmental conditions may affect the health of the plant. Such conditions include unfavorable temperature or moisture, soil acidity or alkalinity, deficiency or excess of certain mineral elements, or air pollution. Air pollution may be caused by the presence of particulate matter or toxic gases.

MEASURES FOR DISEASE PREVENTION

RESISTANT VARIETIES

Grow resistant varieties, if available and fully suitable, in areas where disease problems exist.

SUITABLE SOIL

Make the soil fertile enough to allow for the enormous growth of the tobacco plant within a limited season, and supply all essential elements to the plant. Soil pH (the degree of acidity or alkalinity) must be within the acceptable range. Tobacco grows best in slightly acidic soil. Alkaline soil promotes the severity of black root rot, whereas highly acidic soil increases the availability of manganese causing gray tobacco. Well-decomposed organic matter increases soil fertility. Undecomposed residues of rye are toxic to tobacco and might increase the severity of black root rot. Manure is beneficial to cigar and burley tobacco. High levels of organic matter in the soil promote soil-borne diseases.

PROPER CULTURAL PRACTICES

Growing tobacco in the same soil where tobacco was grown the previous year increases the incidence of black root

rot and virus diseases. Follow recommendations for spacing between plants because close spacing helps spread diseases caused by fungi, bacteria, and viruses.

SANITATION

When pathogenic diseases are diagnosed, remove all diseased leaves and plants to stop the spread of the disease. Eradicate weeds on which viruses overwinter. Control of insects is important in minimizing disease transmission and injury to the plant, where infection may enter. Clean or sterilize your hands, boots, and tools because they may be a source of spreading infection. Do not smoke or chew tobacco when you are in the seedbeds during planting or when you are working in the tobacco field.

CHEMICAL PROTECTION

To avoid high losses from disease, protect your plantings by means of recommended chemicals. The application of such chemicals at the recommended rate and at the right time is essential for maximum protection, for minimum residues in the plant, and to avoid any phytotoxic effect.

STERILIZATION OF TOBACCO SEEDBEDS

Sterilization of tobacco seedbeds is the most effective way of killing weed seeds present in soil and disease organisms such as nematodes, bacteria, fungi, and viruses. Sterilization of the seedbeds is accomplished with either steam or chemicals.

STERILIZING WITH STEAM

In flue-cured and burley tobacco, steaming of the seedbeds in the fall or spring is common practice. Steaming for 30 min at 50°C kills nematodes; at 66°C kills most bacteria and fungi that cause diseases; at 71°C kills most insects and all plant viruses except tobacco mosaic virus; and at 80°C most weed seeds. Before you steam the seedbed, prepare the soil so that it is uniformly loose and moist enough for seed germination. Inject the steam under a metal pan (Fig. 4). For thorough sterilization, you need a temperature of 82°C for 30 min at 15 cm *(6 in.)* deep. Steaming of soil releases certain nutrient elements from a "bound" form to a soluble form, which increases the level of soluble salt in the soil solution. If steaming is carried out for too long, the higher levels of salt may be toxic to the young tobacco seedlings.

Sterilize the walls, walks, and boards with formalin, as recommended.

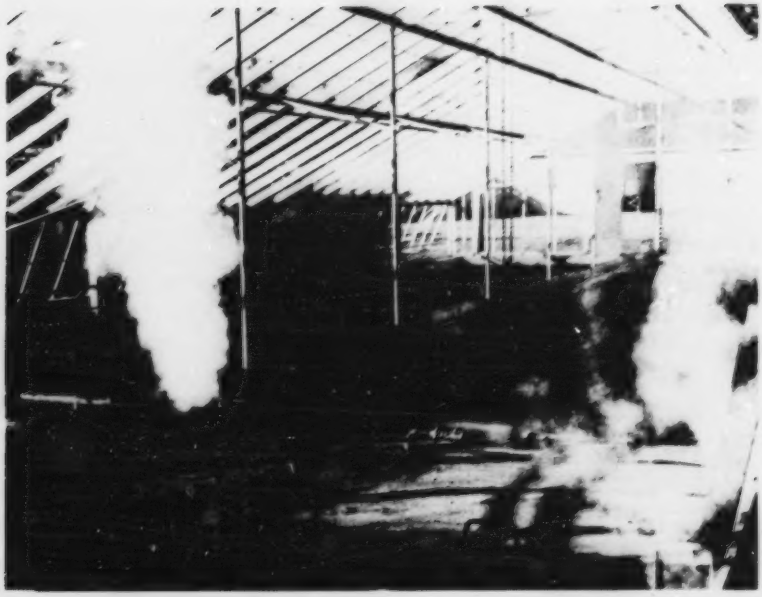


Fig. 4. Steam-sterilization of a tobacco seedbed using a steel pan.

STERILIZING WITH CHEMICALS

Methyl bromide or formalin is recommended in Quebec for sterilizing seedbeds where cigar and pipe tobacco is to be grown. A can of 500 ml of methyl bromide is enough to fumigate 10 m² *(16 oz/100 sq ft)* of seedbed surface. Cover the soil surface with plastic and put the fumigant can in a pail of hot water and place the pail under the plastic. A water temperature between 60° and 70°C helps release the fumes. To keep the fumes under the plastic, cover the plastic with moist soil. Release the fumes under the plastic cover by means of the device on the can. After 24 hr, lift the plastic and let the soil aerate for 2 or 3 days. A formalin solution (1 part formalin to 50 parts water) is commonly used for disinfecting seedbeds of cigar and pipe tobacco. The solution is applied at 25 litres/m² of seedbed *(5 gal/10 sq ft).* Repeat the application after 24 hr, and cover the bed with plastic to hold the formalin vapors in the soil. A day later, remove the plastic cover, loosen the soil, and let it aerate for 7–10 days before seeding.

Chemical control in flue-cured tobacco seedbeds has been carried out by many growers in Ontario. They use allyl alcohol

(AA), Vorlex, or Dazomet (Mylone). When these chemicals were applied according to manufacturers instructions, they satisfactorily controlled weeds in moistened beds, but their effect on black root rot was inconsistent. Thorough steaming seems to be the only reliable means for controlling the disease in muck soil.

DISEASES IN THE SEEDBED

DISEASES CAUSED BY FUNGI

Molds and mushrooms

Various fungi, commonly called molds, grow on the surface of the seedbed or on the tobacco seedlings. These molds do not directly attack the seedlings, but they may interfere with the emergence or the normal development of the seedling. These molds usually develop under moist conditions and low intensity of light. Examples of these are the pink mold (*Pyronema* spp.), slime molds of different colors that spread on the leaves in the form of slimy encrustations, and mushrooms (*Coprinus* spp.).

The green mold often visible on moist beds is a blue-green algae. Algae are a group of water-loving green plants distinct from fungi.

Control. All these molds and algae tend to disappear quickly under bright sun, adequate ventilation, and drying out of the seedbed surface.

Damping-off

Damping-off is mainly caused by *Rhizoctonia solani* Kühn and less often by *Pythium* spp. The disease affects young seedlings as they emerge and causes them to shrivel and die. Infection of older seedlings starts at soil level (Fig. 5) and causes the seedlings to wilt and eventually die. Damping-off is often found in patches (Fig. 6), and in severe cases numerous patches are noticeable throughout the seedbed.

Damping-off organisms can reinfest and establish themselves in steamed beds.

The disease is also favored by incomplete soil sterilization, thick stands of seedlings, humid atmosphere, wet soil in the seedbed, and the use of too much organic fertilizer such as sheep manure.

Control. Proper seeding, sanitation, fertilization, watering, and ventilation are needed to avoid damping-off. Surface sterilize boots or tools with a 4% formaldehyde solution before walking

Fig. 5. Typical symptoms of damping-off. Note the rot at about soil level.

Fig. 6. Cleaned-up patches after damping-off infection.

and working in a sterilized seedbed. Keep the doors of the greenhouse closed and do not allow pets such as cats and dogs near the sterilized seedbeds. In case of infection, follow the recommended chemical treatment.

Black root rot

Black root rot, caused by *Thielaviopsis basicola* (Berk. & Br.) Ferr., is found in tobacco seedbeds where the soil has not been properly sterilized. Infected seedlings are stunted and their leaves are usually light green or yellow because of an improper supply of water and nutrients by the infected roots. Roots are stunted, and black lesions of dead tissue are formed on the main and lateral roots (Fig. 7). Wet and cold conditions increase the severity of black root rot. Tobacco varieties differ in their tolerance for black root rot.

Control. Proper sterilization of the seedbed is essential to avoid black root rot infection.

Fig. 7. Roots of tobacco seedlings with lesions of black root rot.

Blue mold

Blue mold, caused by *Peronospora tabacina* Adam, was first noticed in Ontario in 1938; it occurred sporadically until 1945, and between 1945 and 1947 it was epidemic. Infection during the epidemic was attributed to spore showers carried by favorable winds from exposed tobacco seedbeds in Kentucky and Ohio. Following the epidemic in 1947, the disease declined and has not been recorded since 1966. The

disease did not overwinter or become established in Canada. The source of infection seems to have been checked by effective control measures carried out in the tobacco-growing areas of Kentucky and Ohio.

Blue mold forms yellow blotches on the upper surface of the leaf (Fig. 8) and a grayish blue downy mildew forms on the lower surface. The severity of the disease increases

Fig. 8. Leaves of tobacco seedlings infected with blue mold. Note the discoloration of the upper leaf surface. *Right*, upper surface. *Left*, lower surface.

under humid conditions and below 16°C, and infection may cover the whole surface of the leaf.

DISEASES CAUSED BY NEMATODES

Root-knot

Root-knot, caused by *Meloidogyne hapla* Chitwood, has only been noticed in some seedbeds that were not properly sterilized. The seedlings are yellow and stunted with tiny swellings or knots on the rootlets.

NONPARASITIC DISEASES

Tipping-over

Tipping-over of young tobacco seedlings is noticed in

several seedbeds every year. The tipped-over seedlings shrivel and die. Although the disease has not been fully studied, observations indicate that tipping-over is more common in beds with excessive moisture on the surface or with high levels of salt. Proper watering and fertilizing help decrease the incidence of tipping-over.

Cold injury

Some tobacco varieties such as Virginia 115 are more sensitive to cold than others. After cold, windy nights, the leaves of small seedlings change in shape, become pale in color, and the growing point of the seedling turns white (Fig. 9). When the weather turns warmer, the affected seedlings usually recover and the terminal bud grows normally.

Fig. 9. Seedlings of tobacco cv Virginia 115 showing signs of cold injury. Note the pale colored growing points.

Yellow patch

Irregular patches of yellow stunted seedlings are the characteristic symptoms of yellow patch (Fig. 10). Roots of diseased seedlings exhibit various degrees of discoloration and rotting. In severe cases seedlings wither and die, whereas in milder cases new rootlets develop and the seedlings gradually

Fig. 10. Yellow patch in a seedbed resulting in poor growth of the seedlings.

recover. Yellow patch mainly occurs in compact and poorly drained beds, particularly under cold weather conditions. Excessive fertilization before sowing might also induce yellow patch. Yellow patch is probably a result of the formation of nitrites, which are toxic to tobacco seedlings.

Control. Ensure that all seedbeds are well drained. Keep the soil well forked and loose. Apply uniformly the recommended amount of fertilizer.

Injury by 2,4-D

Tobacco plants are extremely sensitive to the common herbicide 2,4-D. Leaves of affected seedlings are narrow, somewhat strap-shaped, with prominent veins and wavy-toothed margins (Fig. 11). Roots are thickened, clustered, and stunted.

Do not use a sprayer or any other equipment that has been used to apply 2,4-D or other herbicides. Do not store stocks or containers of 2,4-D near growing plants or in adjoining parts of the same building.

Injury by fumes from wood preservatives and paints

Wood preservatives and paint help to prolong the life of

Fig. 11. Injury of tobacco seedlings with 2,4-D. Note the strap-shaped leaves with wavy margins.

wooden greenhouses, but tobacco seedlings in these houses may be injured by the fumes from freshly treated wood and the fumes of fresh paint. The common symptoms are the upward cupping of the leaves and the yellowing of the leaf margins (Fig. 12). To grow healthy seedlings, do not use pentachlorophenol or creosote as wood preservatives in your greenhouse, and finish all your painting jobs at least a few weeks before seeding time.

DISEASES CAUSED BY FLOWERING PLANTS

Field dodder

Field dodder, *Cuscuta campestris* Yunker, is a stem parasite. In tobacco seedbeds, the thin yellow shoots of dodder twine around the tobacco shoots (Fig. 13). They establish contact with the tobacco stems by forming projections or absorbing organs, which penetrate the stem until they reach the vascular tissue of the tobacco seedling. Food from the tobacco stem passes through these absorbing organs to the stem of dodder, which grows rapidly and spreads over the tobacco seedlings, and causes stunting. Broken fragments of

Fig. 12. Tobacco seedlings injured with vapors of a wood preservative. Note the upward cupping of the leaves and yellowing of leaf margins.

Fig. 13. Stem of dodder twining around leaves and stem of a tobacco plant.

the stem of dodder dropped on healthy tobacco seedlings can easily get established on them.

Control. Proper sterilization of the seedbed is necessary to avoid dodder in tobacco seedbeds. Discard tobacco seedlings infested with dodder.

DISEASES IN THE FIELD

DISEASES CAUSED BY FUNGI

Blue mold

Infection with blue mold, caused by *Peronospora tabacina* Adam, may be carried out to the field on transplanted seedlings or may start in the field on healthy seedlings by spore showers. Many yellow circular spots (1–2 cm in diameter) appear on the leaf surface. These spots turn to brown dead tissue. Infection is more common on the lower leaves, but under severe attack all leaves may be affected. As previously mentioned the disease has not been detected in Canada since 1966.

Control. If blue mold occurs, consult extension specialists for specific recommendations on blue mold control.

Black root rot

Black root rot, caused by *Thielaviopsis basicola* (Berk. & Br.) Ferr., is a common disease, particularly in Essex and Kent counties in Ontario and in the tobacco-growing areas in Quebec. Infection occurs only in certain parts of the field and causes stunting of the plants. Under severe infections, plants become yellow and flower prematurely. Under light and moderate infections, new roots form slowly and the plants almost attain their normal size but they mature later. Black lesions form on the main and lateral roots of infected plants (Fig. 14). The fungus present in these lesions can be easily identified microscopically.

The severity of black root rot increases in poorly drained or less acidic soil, particularly under cold and wet conditions. Do not grow tobacco or beans in rotation after tobacco because these crops are hosts for the fungus and will spread the disease. Incompletely decomposed residues of rye were also found to promote black root rot. Crop losses resulting from black root rot are seldom high where tobacco varieties with high tolerance for the disease are grown.

Control. Grow a variety of tobacco that is tolerant of black root rot. Transplants should be healthy and free from disease lesions. Follow the recommended rotation for growing tobacco.

Fig. 14. Dark lesions of black root rot formed on main and lateral roots of tobacco.

Sore-shin

Rhizoctonia solani Kühn is a common soil-borne fungus that causes sore-shin, which is responsible for some damage in all tobacco-growing areas. The fungus attacks the tobacco stems at soil level and secretes enzymes that destroy the cells and form brownish areas, which may extend upward and downward and sometimes girdle the stem. In mild infections tissue destruction is superficial, but in severe cases both cortical and vascular tissues are invaded by the fungus, which weakens the plant until it topples over (Fig. 15).

Sore-shin occurs over a wide range of temperatures and is favored by intermediate moisture, although it can occur in fairly dry soil.

Early severe infection with sore-shin causes the extreme stunting of the tobacco transplants with symptoms at this stage similar in many aspects to those of black shank, including disking of the pith tissue; black shank has not been recorded in Canada.

Control. Check carefully that all transplants are free from any trace of damping-off. Avoid injuring the transplants by handling them carefully and controlling insect pests.

Fusarium wilt

Fusarium wilt, caused by *Fusarium oxysporum* Schlecht.f. *nicotianae* Snyd. & Hansen, is a soil-borne disease that is

Fig. 15. A severe infection with sore-shin causing the separation of the top from the root of a tobacco plant.

favored by moderately high air temperatures and therefore is of minor importance in Canada.

The disease has been observed on plants at the flowering stage. Yellowing and wilting of the leaves are the common symptoms. Usually these symptoms are confined to leaves on one side of the mature plants (Fig. 16). Leaves on the affected side are sometimes dwarfed and midribs are curved. If midribs of diseased leaves are longitudinally split, brownish discoloration of the vascular tissue is always noticed.

The fungus usually enters the root through wounds that expose the vascular tissue. It is also believed that infection of roots by nematodes increases the chance of infection. The fungus spreads in the vessels and partly blocks them, thus

Fig. 16. Fusarium wilt causing plants to wilt during a hot day.

slowing down the water supply to the plant. The fungus also secretes enzymes, which cause browning of the xylem vessels.

Fusarium wilt infects plants other than tobacco such as potatoes and tomatoes. The disease spreads from one locality to another on infected plants or plant material.

Control. Sanitation and a 2- to 3-year crop rotation help to control nematodes in the soil and decrease disease incidence.

Verticillium wilt

Verticillium wilt, caused by *Verticillium negrescens* Pethybr., has been recorded only in Quebec on a few cigar tobacco plants in 1972 and 1973. The characteristic symptoms are the wilting of the lower leaves with the interveinal areas turning bright orange. Gradually these areas turn brown with an orange rim between the healthy and the diseased part of the lamina. Brown discoloration of the vascular tissue of the stem and midrib becomes visible, and in severe cases infection extends to all leaves and the plant dies.

Control. Sanitation and proper crop rotation are essential.

Brown leaf spot

Brown leaf spot, caused by *Alternaria alternata* (Fries) Keissler, causes serious losses in tobacco-growing countries that have warm climates. Losses caused by brown leaf spot have been low in Canada. The disease starts as water-soaked circular spots formed on the mature lower leaves. These spots

Fig. 17. A severe infection with brown leaf spot.

enlarge to 1–3 cm and their centers turn brown. At this stage, brown concentric spots with or without yellow halos are the characteristic symptoms (Fig. 17). Under humid conditions, these spots coalesce, causing damage to the entire leaf.

The disease spreads by spores that germinate in a film of water on the leaf surface and the germ tubes penetrate the leaf tissue. The fungus inside the leaf secretes enzymes that kill the neighboring cells, leading to the formation of the brown spots.

Control. Consult extension specialists for specific recommendations for control of brown spot.

Frog eye

Frog eye, caused by *Cercospora nicotianae* Ell. & Ev., is of little importance. Small brown spots, usually not more than 6 mm in diameter, form on the mature leaves. The spots have parchmentlike centers scattered with minute black dots that denote the masses of the reproductive units of the fungus (Fig. 18).

The fungus usually enters the leaf through the stomatal pores, and the subsequent formation of lesions occurs from one to several weeks later, depending on air temperatures; warmer weather promotes the formation of lesions. Overmature leaves are more susceptible to frog eye.

Control. Follow the recommended rotation for tobacco. Plow under infected refuse. Prime tobacco leaves at the proper stage of maturity. Do not overfertilize with nitrogen.

Fig. 18. Spots of frog eye with dead centers formed on a tobacco leaf.

Stalk rot or rattle box

The causal fungus of stalk rot, *Sclerotinia sclerotiorum* (Lib.) de Bary, infects tobacco plants during harvest through wounds caused by topping, suckering, or bruising. In the pith tissue of the stem the fungus forms white mycelium, which gradually consumes the soft pith tissue. Hard black sclerotia are formed inside the pith tissue (Fig. 19). Externally a canker

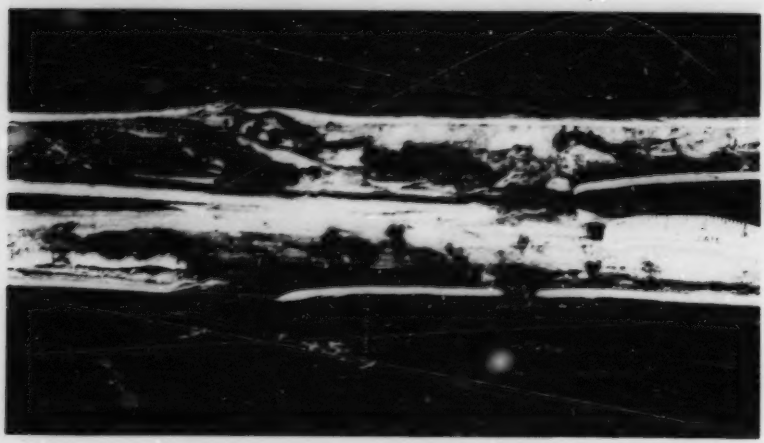


Fig. 19. The fungus causing stalk rot forms hard black sclerotia inside the stalk of an infected plant.

forms close to the leaf base and extends for about 10 cm in an oval pattern. When a dry diseased plant is shaken, the sclerotia rattle in the hollow stem and hence the name "rattle box." This disease is of no significance in Canada.

Dead-blossom leaf spot

Late in the flowering stage some tobacco flowers fall onto the leaves where they stick to the upper surface of the lamina by their gummy secretions. Under wet conditions, the fungi *Botrytis cinerea* Pers. and *Sclerotinia sclerotiorum* (Lib.) de Bary grow under the flower petals and into the cells of the leaf, and a dark dead spot develops (Fig. 20).

Control. Top and sucker your plants at the right time.

DISEASES CAUSED BY BACTERIA

Angular leaf spot

Angular leaf spot, caused by *Pseudomonas angulata*

Fig. 20. Dead-blossom leaf spot formed on a tobacco leaf.

(Fromme & Murray) Holland, forms brown spots on the leaves of plants approaching maturity (Fig. 21), particularly after heavy rainstorms and high winds. Severe showers cause the formation of water-soaked spots in the leaves; the organism multiplies very fast in these areas and a dark necrotic (dead) center develops that gradually expands, forming lesions of different sizes.

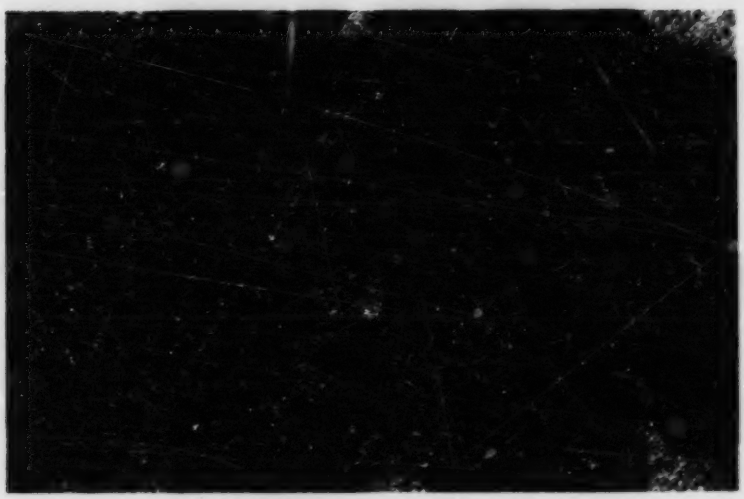


Fig. 21. Angular leaf spot on tobacco leaves.

Wind and heavy rainfall are the main agents that spread the disease. Splashing rain spreads the bacteria from infected to healthy leaves and from plant to plant. High-nitrogen and low-potash fertilization increase leaf susceptibility to water-soaking, which is a contributing factor in the multiplication of the organism. The organism lives on roots of weed, pasture, and crop plants and overwinters on undecomposed plant residues.

Control. Avoid high-nitrogen and low-potassium fertilization. To combat infection, proper sanitation and adequate crop rotation are essential.

Wildfire

Angular leaf spot and wildfire are closely related diseases that are caused by *Pseudomonas angulata* (Fromme & Murray) Holland and *Pseudomonas tabaci* (Wolf & Foster) Stev. Although they are considered two different species, there is strong evidence that they are two variants of one species. They are identical in all features except one: *P. tabaci,* which causes wildfire, produces a toxin that stimulates the formation of a yellow halo around the brown necrotic spots. The presence of these yellow halos is the main diagnostic feature for the differentiation between wildfire and angular leaf spot.

Fig. 22. Stem of a tobacco plant split lengthwise to show symptoms of hollow stalk.

Hollow stalk

Hollow stalk, caused by *Erwinia carotovora* (L. R. Jones) Holland, is a soft rot that infects tobacco plants late in the season, particularly after topping and suckering. Wounds and high humidity promote hollow stalk. The bacterium reaches the pith of the stem, where it multiplies under humid conditions and secretes enzymes that cause the disintegration of the pith cells, and the stem becomes hollow (Fig. 22). Wounds caused by concentrated suckering materials contribute to hollow stalk.

Control. Avoid topping and suckering in damp cloudy weather. Use the right dilution of suckering chemical.

Frenching

The early stages of frenching, induced by *Bacillus cereus* Frankland & Frankland, might be mistaken for tobacco mosaic. The growing point of a newly frenched plant is nearly white. Chlorosis starts at the margins of young leaves and spreads toward the midrib; thus the whole leaf becomes yellow with green midrib and veins. Later, frenched leaves may turn to dark green. Leaves of affected plants are long and narrow with tips cupped downward (Fig. 23). In severe cases, the plants

Fig. 23. Frenching of tobacco. Note the color and shape of the leaves.

are stunted and the leaves are reduced to narrow straps. A large number of such leaves are carried on one plant, particularly on the lateral branches (suckers).

There is evidence that frenching can be induced by a toxin produced by the common soil bacterium *B. cereus.* Frenching has been found in new poorly drained tobacco land. The problem disappears after several tobacco croppings.

DISEASES CAUSED BY NEMATODES

Brown root rot

Similar to black root rot, brown root rot, caused by *Pratylenchus penetrans* (Cobb) Filipjev & Stekh., causes stunting and yellowing of tobacco plants in certain spots in the field. In contrast to black root rot, brown root rot is more common on well drained sandy soils and the lesions on the roots are brown and not as dark as those of black root rot (Fig. 24). Microscopic examination of the lesions and nematode counts in soil and root samples are sometimes needed for identifying the disease.

The root lesion nematode lives in the soil and feeds on the roots of tobacco, weeds, and the rotation crops. In spring

Fig. 24. Brown root rot lesions on tobacco roots caused by the root lesion nematode.

they attack the young roots of tobacco transplants and damage their cortical cells. Small lesions form, which gradually expand because of the propagation of the nematodes in these lesions. The population of nematodes decreases during winter and they survive on roots of tobacco, corn, rye, crab grass, and many other plants. In spring, high populations of nematodes can usually be recovered from under the cover crop.

Control. Apply soil fumigants or other nematicides as recommended. Summerfallowing reduces nematode population but promotes erosion of soil by wind.

Root-knot

The aboveground symptoms of the root-knot disease, caused by *Meloidogyne hapla* Chitwood, are similar to those of the root lesion and black root rot, but the symptoms on the roots are very distinct. Galls or knots are formed on the main and lateral roots and these may be enlarged as a result of the formation of these galls side by side (Fig. 25).

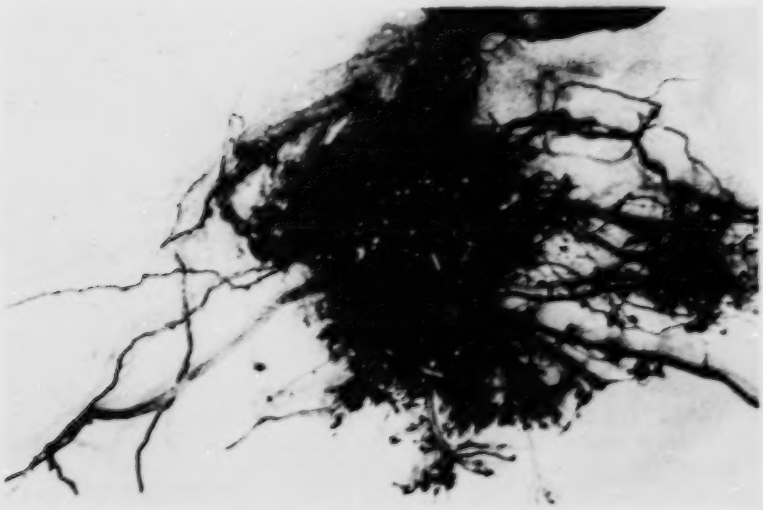


Fig. 25. Knots of different sizes on a tobacco root infected with root-knot nematode.

The root-knot nematode does not parasitize the roots of grasses, and high soil temperatures accelerate its life cycle.

Consequently, root-knot of tobacco is not common in Canada because of the common tobacco–rye rotation and the low soil temperature during the winter in comparison with that of other tobacco-growing countries.

Control. Follow the rotation recommended for tobacco.

DISEASES CAUSED BY VIRUSES

Tobacco mosaic

Infection with tobacco mosaic virus (TMV) may start in the seedbed but symptoms usually do not develop in the leaves before transplanting. The symptoms of the disease are mottling of the leaves, indicated by light and dark green areas intermingled on the lamina (Fig. 26); the younger leaves are lighter in color and sometimes distorted; and the plants are

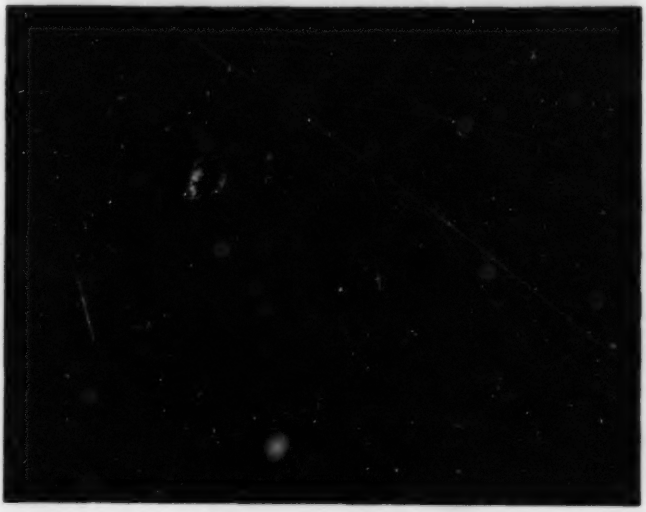


Fig. 26. Mottling of tobacco leaves including the terminal bud caused by tobacco mosaic virus.

usually stunted. The leaves of diseased plants are lower in grade when they are cured because they often have green spots.

TMV infects many hosts including potato, tomato, and pepper plants, as well as perennial weeds such as ground-

cherry, horse-nettle, and jimsonweed. The virus can overwinter in the roots and refuse of infected tobacco and other hosts, and can survive for several months in the soil. The virus can be transmitted by the hands of growers and workers who smoke or chew tobacco while they are working in the tobacco seedbeds or fields. This disease spreads mainly by someone touching a diseased plant and then a healthy tobacco plant. Insects play a minor role in spreading the disease. Tobacco transplants are susceptible to TMV, particularly under wet conditions.

Control. Do not smoke or chew tobacco while you are handling tobacco plants in the seedbed or the field. Weeding and cultivation are essential to eliminate potential hosts of the virus, but do not cultivate while tobacco plants are wet. Do not grow tomatoes, peppers, or potatoes close to tobacco. Follow good rules of sanitation: dispose of diseased tobacco plants, control weeds, and keep your hands, tools, and machinery clean. Top and sucker (if hand-suckering) the healthy plants first, then the diseased plants.

Cucumber mosaic

Cucumber mosaic is common in areas where vegetables, particularly cucumbers, are grown. Symptoms are similar to those of tobacco mosaic virus. The virus spreads mechanically by touch, as well as by aphids.

Control. When populations of aphids are high, use an aphicide. Follow the recommendations for control of tobacco mosaic.

Ringspot

Ringspot can be easily recognized by the light-colored concentric ring patterns formed on the leaves of diseased plants (Fig. 27). The leaf tissue in these patterns gradually breaks down and diseased plants are usually stunted. Ringspot virus has a wide host range including weeds and leguminous plants. The disease is spread mechanically, by insects, and probably by some nematodes.

Control. Follow the recommended crop rotation and do not grow alfalfa, clover, or peas close to tobacco. Remove weeds and diseased tobacco plants.

Streak

During the active stage of tobacco growth, streak virus induces necrosis and downward curling of the young leaves. Dark lesions are formed on the stem and leaf midrib and the

Fig. 27. A tobacco leaf infected with ring spot virus. Note the circular striations.

small veins become dark. Though affected leaves are smaller and the plant appears to be dying, almost normal growth resumes and new leaves are formed. This remarkable recovery from severe symptoms of disease to almost normal growth distinguishes streak from other virus diseases.

Streak virus has a wide host range including crop plants such as beans, peas, white clover, and peanut, as well as weeds such as burdock and bindweed.

Control. Follow the recommended crop rotation and sanitation procedures.

Etch

This virus disease became epidemic in the late 1940s in the burley tobacco-growing area of southwestern Ontario. In recent years, the growing of resistant varieties and early field planting have reduced damage from this virus. Symptoms of tobacco etch virus usually appear on plants at or approaching the flowering stage. Vein-clearing followed by necrosis of the veins and fine necrotic stippling of the leaf blades are the common symptoms. Two to three weeks after infection some leaf mottling is caused by etch and is similar to that caused by mosaic except that in etch the tip leaves show little mottle (Fig. 28). In severe cases, infected plants are stunted and have

Fig. 28. A burley tobacco plant infected with etch virus causing stunting of the plant and mottling of the body leaves but not the terminal bud.

a "fired" and "tattered" appearance. Earlier studies indicated that virulent strains of etch virus in Canada are more destructive to burley than to flue-cured, dark, and cigar varieties. Tobacco etch virus infects many plants such as pepper, tomato, ground-cherry, and jimsonweed and is readily transmitted by aphids.

Control. Eradicate weeds, control aphids, and in etch-infected areas set tobacco plants in the field as soon as possible after the danger of frost is past.

Potato virus Y

Tobacco infection with potato virus Y usually causes vein banding. When this occurs, the leaf tissue between the major veins becomes lighter in color, leaving a band of dark green tissue along both sides of the veins. Stunting of infected plants and mottling of sucker leaves are common symptoms of the disease.

A certain strain of potato virus Y called the tobacco veinal necrosis virus (TVNV) can be very destructive to tobacco. Infection with this strain causes the fine veins of the leaf to turn brown or black and necrosis extends from the midribs of the leaves to the vascular tissue of the stem (Fig. 29). Leaves of mature plants grow faster and, if stem necrosis is severe, the whole plant withers and dies. TVNV infects other crops such as tomatoes and peppers, and weeds such as ground-cherry, nightshade, and horse-nettle.

The disease is mainly transmitted by winged aphids. Fast spread of the disease depends on the activity and propagation of the insect.

Control. Because this virus can be carried in potato tubers, do not grow potatoes of unknown origin. Use certified potato seed. Do not grow potatoes, tomatoes, or peppers near plantings of tobacco. Eradicate perennial weeds and use aphicides.

DISEASES CAUSED BY FLOWERING PLANTS

Broom rape

Broom rape, *Orobanche* sp., is a white, yellow, or purple plant lacking chlorophyll. It parasitizes the roots of several plants including tobacco. Leaves are small and scalelike and when the plant is mature the stem carries a cluster of flowers. Several broom rape plants can parasitize one tobacco plant (Fig. 30). Early attack by broom rape causes stunting of tobacco, whereas late attack causes reduction of leaf quality.

Fig. 29. Flue-cured tobacco infected with potato virus Y. Note the darkening of some veins.

The broom rape plant produces a large number of seeds, which remain viable in the soil for a long time. In the presence of tobacco roots they are stimulated to germinate and become attached to tobacco roots from which they get their nourishment.

Control. The disease is of no economic importance, so control is of little interest.

NONPARASITIC DISEASES

These diseases are not caused by an organism and therefore they are not contagious. Nonparasitic diseases may be caused by air pollution; by climatic conditions such as lack or excess of rain, hail, frost, or lightning; or by lack or excess of mineral elements.

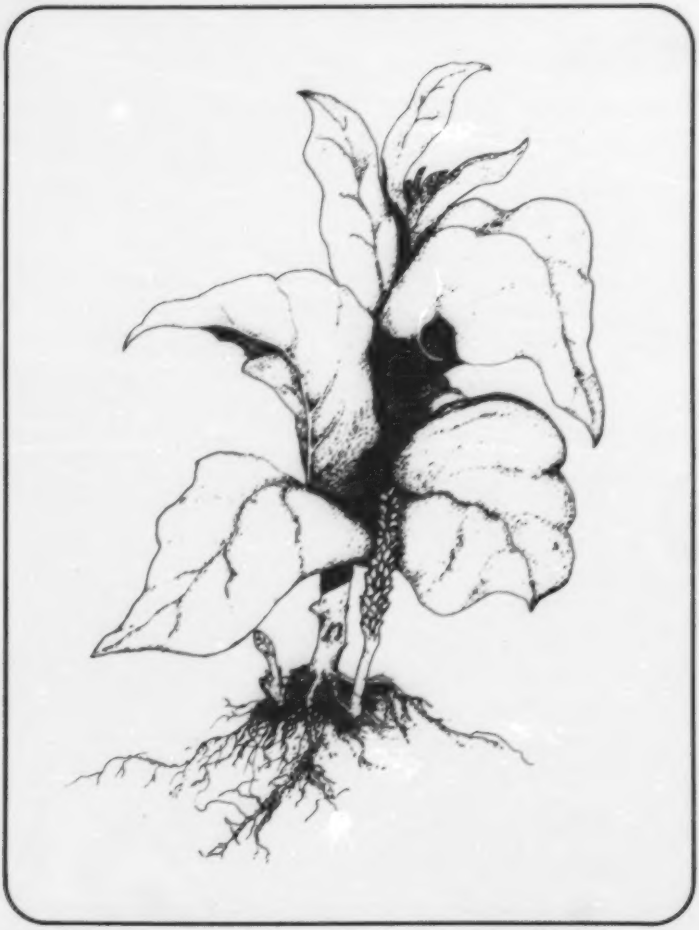


Fig. 30. A diagram showing broom rape as a parasite on the roots of a tobacco plant.

Weather fleck caused by air pollution

At or close to harvesting, tiny brown or black spots 1–3 mm in diameter are first visible on the upper surface of the mature tobacco leaves at the bottom of the plant (Fig. 31). These spots sometimes change to gray or white. Under severe conditions, the spots join and the injury extends from the palisade to the spongy cells, and all the tissue between the upper and lower surface collapses. In some cases the affected

Fig. 31. Weather fleck on tobacco leaves showing tiny dead spots caused by air-pollution damage.

tissue of the lamina falls out, producing a shot-hole effect. Later in the season and with the gradual maturation of the upper leaves, weather fleck starts to show on these leaves.

Weather fleck is most severe in farms bordering or close to Lake Erie, where prevailing winds with a high level of ozone and misty or foggy conditions damage mature tobacco leaves. Ozone passes through the stomatal pores and damages the palisade cells.

Injury caused by weather fleck increases during heavy rain or irrigation and when nitrogen levels in the soil are low.

Control. Grow a tobacco variety tolerant of weather fleck. Follow the recommendations on spacing and topping. In wet seasons add side-dressing to avoid low levels of nitrogen in the soil when the plants are mature.

Frost damage

Because of the short growing season, a late frost in spring can damage or kill all or some of the transplants in the field and total or partial replanting is therefore necessary, whereas an early frost at the end of the growing season might cause serious damage to the unharvested tobacco leaves (Fig. 32).

Fig. 32. Unharvested tip leaves damaged by frost.

Lightning injury

The tobacco fields are sometimes hit by lightning, which causes severe damage to the plants in the center of the plantings, often killing them. Affected plants show a brown to black band along the stem and leaf midribs, and leaves become distorted and puckered. Further growth of the uninjured side of the stems causes the tip of the plant to become twisted. When you slit open the stalk of an injured plant longitudinally, you find that the pith tissue is segmented into disks (Fig. 33).

Hail injury

Almost every season some tobacco fields suffer severely from hail damage. Gray sunken spots form on the plant stems and leaf midribs when they are hit directly by hailstones (Fig.

Fig. 33. ***Upper,*** **Distorted and puckered leaves of tobacco plants hit by lightning.** ***Lower,*** **Plants in the field that have been injured by lightning.**

34). Hail damage is usually not severe when it hits small plants early in the season. Older plants with larger leaves are severely damaged when hail shreds the lamina.

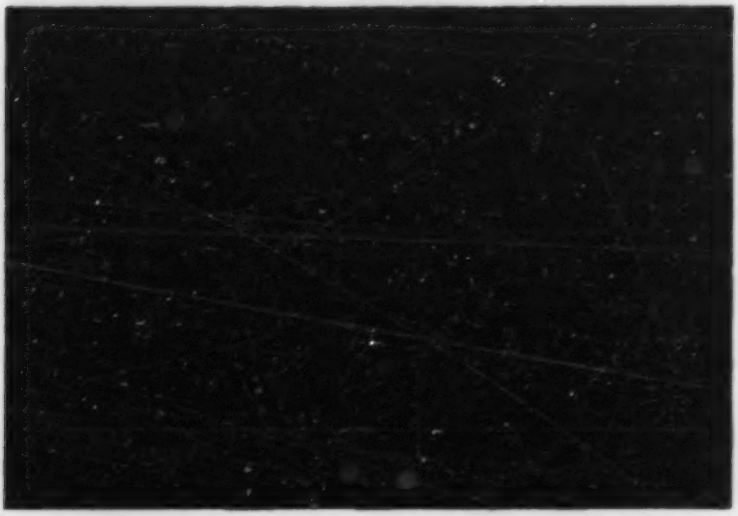


Fig. 34. Damaged leaves of tobacco plants hit by a hail storm.

Sun scald or sun burn

In warm weather, rapidly growing leaves may wilt in intense sunlight, even when soil moisture is adequate. The wilted areas fold, turn brown, and die. Turned-over mature leaves exposed to intense sunlight scald and form dead spots.

Drought spot

Drought spot is usually noticeable when prolonged dry weather prevails. Many brown red spots surrounded by yellow tissue form on the lamina between the veins of the leaf, usually away from the main veins (Fig. 35). These spots enlarge, unite, and form large irregular patches of dead tissue.

Tobacco plants can be protected to a certain extent against drought spot by increasing the chlorine, nitrogen, and potash content of the fertilizer. Contact your provincial authorities for advice on the amounts to be added.

Topping height has been found to influence the severity of breakdown of tissue caused by drought. The lower the topping, the greater the injury with drought spot.

Drowning

Tobacco grows best in well drained soils, because air is needed for the tobacco roots to function properly. Drowning

Fig. 35. Brown and yellow areas on the leaves caused by drought.

of tobacco occurs if the roots remain 24–48 hr in waterlogged soil. The roots cease to function and the plants suddenly wilt and flop (Fig. 36). The leaves become dry but remain attached to the plant.

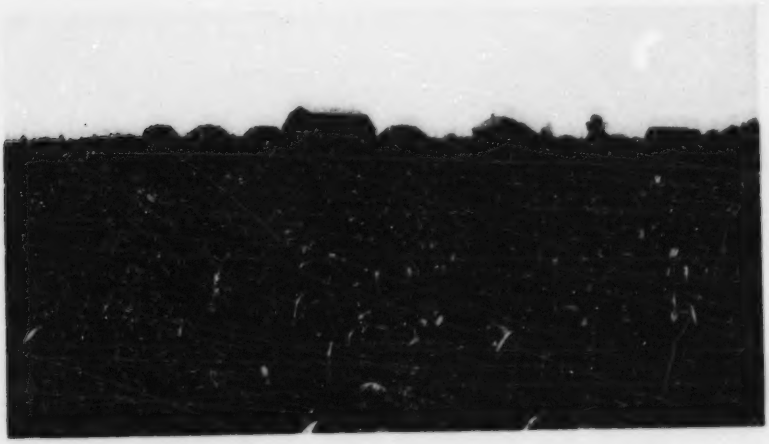


Fig. 36. Tobacco plants drowned in a poorly drained field after heavy rain. Note the wilting and flopping of the plants.

NUTRITIONAL DISEASES

Nutritional diseases may be caused by either a lack or an excess of certain food plant elements in the soil. Although nitrogen, phosphorus, and potassium are the main elements in fertilizers, other elements such as magnesium, calcium, boron, sulfur, manganese, zinc, copper, and iron are also essential for tobacco production. Boron, zinc, copper, and iron are required in only very small quantities and they are called micronutrients. In soil management, carefully consider the amount of fertilizer to use and the elements contained in it.

Nitrogen deficiency

A deficiency of nitrogen causes stunting of tobacco plants. Leaves at the bottom of the plant are pale green or yellow and later become brown and dry (Fig. 37). Plants that are supplied with an adequate amount of nitrogen as soon as deficiency symptoms start to show may recover. Tobacco plants that are not given enough water produce symptoms similar to those of nitrogen deficiency.

Fig. 37. Stunting of tobacco plants and yellowing of the lower leaves caused by nitrogen deficiency.

Excess of nitrogen

An excess of nitrogen induces vigorous growth of plants having larger, extraordinarily green leaves. The leaves of flue-

cured tobacco, given excess nitrogen, fail to ripen and their quality is reduced.

Phosphorus deficiency

A deficiency of phosphorus delays tobacco growth. Leaves are dark green and somewhat narrow. Many whitish spots form on the lower leaves and fewer darker ones on higher leaves.

Potassium deficiency

A deficiency of potassium causes yellowing of leaf tips and the tissue between the veins; the tissue later becomes necrotic and might fall out. The tip and margin of the leaf cease to grow, whereas the inner portion of the lamina continues to grow, causing the tip and margin to cup downward (Fig. 38). Similarly, portions of lamina between the main veins

Fig. 38. The cupping downward of the tip and margin of the leaves caused by potassium deficiency.

curve upward. When the leaves are cured, they are thin, dull, brittle, and of poor quality.

Magnesium deficiency

Because magnesium is a constituent of the green and yellow pigment of the plant, a deficiency of this element is shown by the lack of green color. In plants approaching maturity, the tips, margins, and interveinal areas of the lower leaves become yellow, whereas the midrib and the veins remain green. Under severe deficiency, leaves of the whole plant turn yellowish white (Fig. 39).

Fig. 39. Magnesium deficiency results in yellowing of the leaves, whereas midribs and veins may still be green.

Calcium deficiency

A deficiency of calcium causes young leaves in the buds to turn yellow and their tips to hook downward. Young leaves are distorted. The plant might not form flowers, but if they form they are distorted and sterile. Terminal and lateral buds may be killed under conditions of severe deficiency.

Boron deficiency

A deficiency of boron causes leaves of the terminal bud to turn paler and the entire bud becomes dry. If the bud

survives, it produces twisted and distorted leaves. The conducting tissue of the leaves becomes dark.

Sulfur deficiency

A deficiency of sulfur is rare in the field, but its symptoms may appear on young plants during dry periods. Young leaves are chlorotic and the smaller veins are light green.

Manganese deficiency

A deficiency of manganese is noticed only in tobacco grown on neutral and alkaline soil. The plants are usually stunted. The interveinal areas of the leaves become light green to white, whereas the veins remain darker. Tiny dark spots that turn yellow form on the leaves.

Zinc deficiency

A deficiency of zinc has not been detected in the field, but laboratory studies have shown that its deficiency causes yellowing of older leaves. Necrotic spots spread rapidly on these leaves. Later, leaf veins also turn brown.

Copper deficiency

A deficiency of copper has not been detected in the field. A copper deficiency causes loss of turgidity of the upper leaves and the growth of leaves is retarded. There are no signs of color change or formation of spots.

Iron deficiency

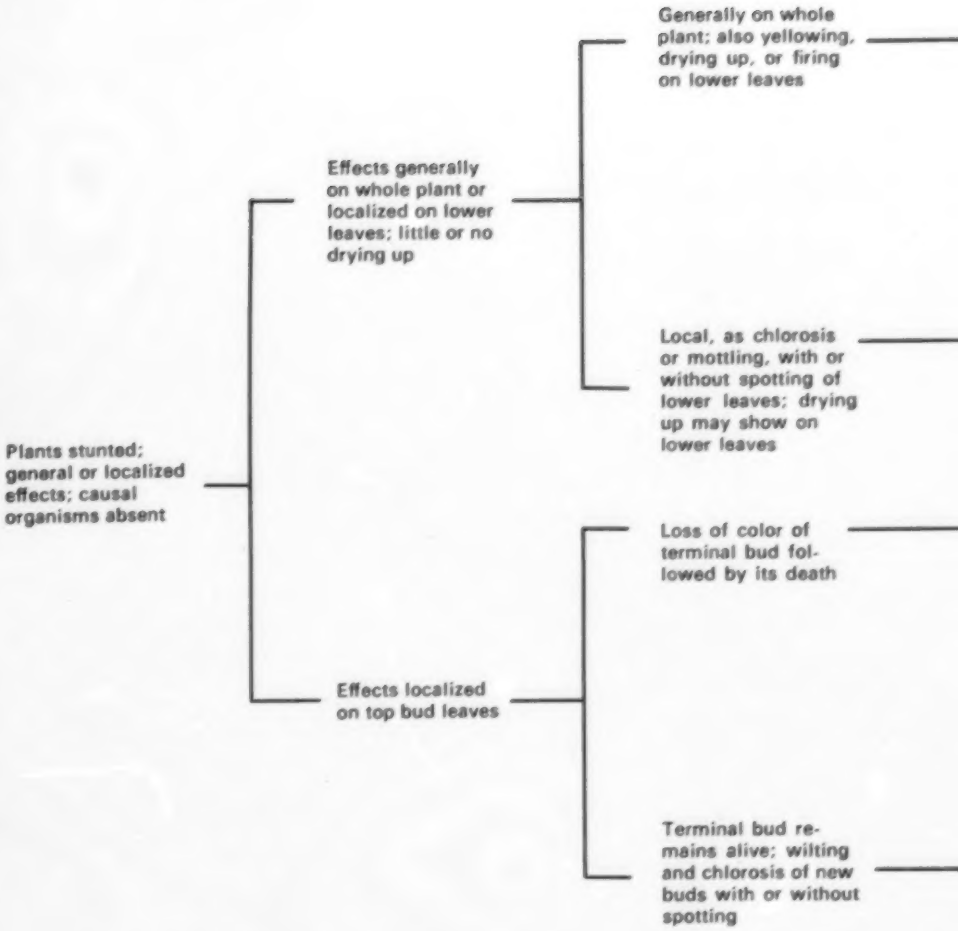
Iron deficiency is rarely seen in the field. Chlorosis starts in the young leaves at the tip of the plant. Interveinal areas become almost white, whereas the veins remain green. No spots form on the leaves.

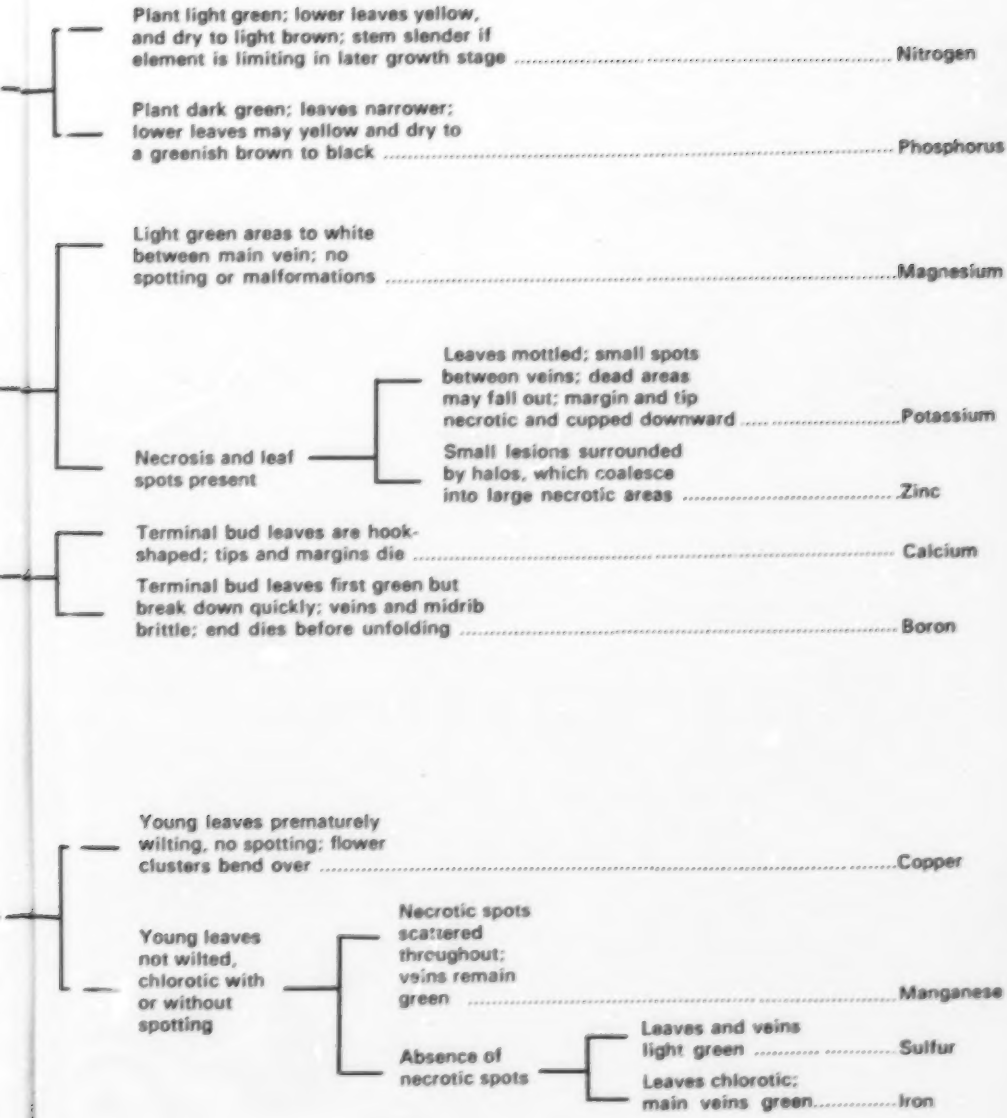
Gray tobacco

Gray tobacco has been found in certain areas in Ontario and Quebec. In the field, leaves approaching maturity have a bronze shading and a peppery appearance. After they have been cured, these leaves become blended or variegated gray with tiny black spots (Fig. 40). The leaves have a musty odor when they are cut into cigarette filler. Gray leaves are higher in manganese, iron, and zinc than the nongray leaves.

Gray tobacco in the field is mainly caused by manganese toxicity. The disease is more common in acidic soil, where manganese is absorbed faster by the plant.

KEY TO MINERAL DEFICIEN


Plants stunted; general or localized effects; causal organisms absent
Effects generally on whole plant or localized on lower leaves; little or no drying up
Generally on whole plant; also yellowing, drying up, or firing on lower leaves
Local, as chlorosis or mottling, with or without spotting of lower leaves; drying up may show on lower leaves
Effects localized on top bud leaves
Loss of color of terminal bud followed by its death
Terminal bud remains alive; wilting and chlorosis of new buds with or without spotting


Plant light green; lower leaves yellow, and dry to light brown; stem slender if element is limiting in later growth stage
Nitrogen
Plant dark green; leaves narrower; lower leaves may yellow and dry to a greenish brown to black
Phosphorus
Light green areas to white between main vein; no spotting or malformations
Magnesium
Necrosis and leaf spots present
Leaves mottled; small spots between veins; dead areas may fall out; margin and tip necrotic and cupped downward
Potassium
Small lesions surrounded by halos, which coalesce into large necrotic areas
Zinc
Terminal bud leaves are hook-shaped; tips and margins die
Calcium
Terminal bud leaves first green but break down quickly; veins and midrib brittle; end dies before unfolding
Boron
Young leaves prematurely wilting, no spotting; flower clusters bend over
Copper
Young leaves not wilted, chlorotic with or without spotting
Necrotic spots scattered throughout; veins remain green
Manganese
Absence of necrotic spots
Leaves and veins light green
Sulfur
Leaves chlorotic; main veins green
Iron

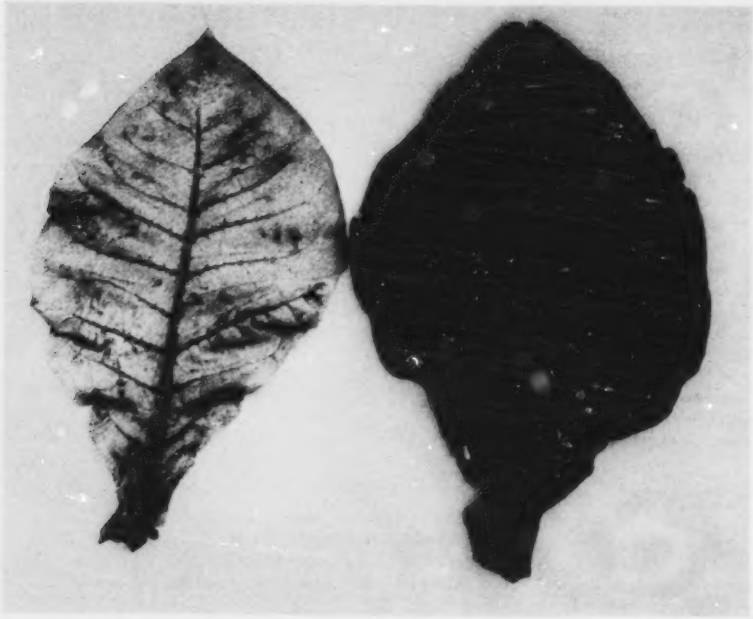


Fig. 40. Two cured tobacco leaves; the leaf at the left is normal and the one at the right is gray because of an excess of manganese.

DISEASES IN THE CURING BARN OR KILN

Pole rot, barn rot, or house burn

Several fungi and certain bacteria attack tobacco leaves during air- or flue-curing, particularly when the relative humidity inside the barn or kiln is over 80%. The growth of some organisms is so fast at these high relative humidities that severe damage takes place during the early stage of curing.

Pole rot of flue-cured tobacco is mainly caused by *Rhizopus arrhizus* Fischer and partly by *Erwinia carotovora* (L. R. Jones) Holland and other organisms. This disease was of minor importance during the 1950s, but is now one of the major disease problems of flue-cured tobacco in Canada. Apparently larger-leaved varieties, improved cultural practices, and more effective harvesting operations have led to a larger kiln load and increased humidity during curing. Moreover, the utilization of the tying machine resulted in more injury of tobacco leaf butts. Pole rot infection is enhanced by high

humidity during the yellowing stage of curing and by leaf injury.

The disease starts during the yellowing stage of curing when water-soaked areas are formed on the leaf butt at the injury usually caused by tying tobacco to the lath or by handling. The infected area enlarges, darkens in color to brown or black, and may cover a large portion of the lamina (Fig. 41). In most cases the grayish growth of the fungus spreads over the affected parts of the leaf, which are soggy and slimy.

Fig. 41. Pole rot of flue-cured tobacco. Note the grayish fungus spreading on the diseased part of the leaves.

Pole or barn rot of air-cured tobacco is common on burley tobacco in Ontario and on cigar tobacco in Quebec. Organisms causing rot to air-cured tobacco are different from those of the flue-cured tobacco. Thin-leaved tobacco varieties are more susceptible to the disease, probably because of frequent injury and bruising. Infected leaves are soggy. The stem is usually covered with one or more molds, which spread to the pith causing the disintegration of its tissue (Fig. 42).

Control. Avoid bruising or injuring tobacco during harvesting. Kiln or barn load should not be excessive. Do not cure wet or unripe tobacco. Humidity should be kept adequate enough for

Fig. 42. A stem of a cigar tobacco plant split lengthwise to show the fungus that causes pole rot spreading inside the stem.

color change. Proper ventilation and air circulation are necessary in case of high humidity. Discuss with your regional tobacco specialist the possibility of using chemical disinfectants.

ACKNOWLEDGMENTS

The author is especially grateful to M. C. Watson and N. W. Sheidow, tobacco specialists, Ontario Ministry of Agriculture and Food, for contributing photographs for many of the figures in this bulletin and for relevant information. I am also grateful to Dr. C. D. McKeen, research coordinator, Agriculture Canada, for critically reviewing the manuscript and providing useful information on tobacco etch virus based on his own experience.

The author is also greatly indebted to D. A. Brown, Delhi Research Station, for drawing the diagrams for Figs. 1, 2, 3, and 30; to Dr. G. B. Lucas, North Carolina State University, Raleigh, for contributing Figs. 18, 20, and 33; to Dr. G. V. Gooding, North Carolina State University, Raleigh, for contributing a photograph for Fig. 29; and to J. M. Elliot, Delhi, Ont., for contributing a photograph for Fig. 24.

CONVERSION FACTORS FOR METRIC SYSTEM

Imperial units	Approximate conversion factor	Results in:	
LINEAR			
inch	x 25	millimetre	(mm)
foot	x 30	centimetre	(cm)
yard	x 0.9	metre	(m)
mile	x 1.6	kilometre	(km)
AREA			
square inch	x 6.5	square centimetre	(cm^2)
square foot	x 0.09	square metre	(m^2)
acre	x 0.40	hectare	(ha)
VOLUME			
cubic inch	x 16	cubic centimetre	(cm^3)
cubic foot	x 28	cubic decimetre	(dm^3)
cubic yard	x 0.8	cubic metre	(m^3)
fluid ounce	x 28	millilitre	(mL)
pint	x 0.57	litre	(L)
quart	x 1.1	litre	(L)
gallon	x 4.5	litre	(L)
WEIGHT			
ounce	x 28	gram	(g)
pound	x 0.45	kilogram	(kg)
short ton (2000 lb)	x 0.9	tonne	(t)
TEMPERATURE			
degrees Fahrenheit	(°F-32) x 0.56 or (°F-32) x 5/9	degrees Celsius	(°C)
PRESSURE			
pounds per square inch	x 6.9	kilopascal	(kPa)
POWER			
horsepower	x 746	watt	(W)
	x 0.75	kilowatt	(kW)
SPEED			
feet per second	x 0.30	metres per second	(m/s)
miles per hour	x 1.6	kilometres per hour	(km/h)
AGRICULTURE			
gallons per acre	x 11.23	litres per hectare	(L/ha)
quarts per acre	x 2.8	litres per hectare	(L/ha)
pints per acre	x 1.4	litres per hectare	(L/ha)
fluid ounces per acre	x 70	millilitres per hectare	(mL/ha)
tons per acre	x 2.24	tonnes per hectare	(t/ha)
pounds per acre	x 1.12	kilograms per hectare	(kg/ha)
ounces per acre	x 70	grams per hectare	(g/ha)
plants per acre	x 2.47	plants per hectare	(plants/ha)